Edward Walter and Kiki Steel

Management of exertional heat stroke:

a practical update for primary care physicians

E Walter, MRCP, FRCA, FFICM, MFMLM, DipIMC RCSEd, consultant in intensive care medicine and anaesthesia, Royal Surrey County Hospital, Guildford. **K Steel**, MSc, DRCOG, DFSRH, GP, Market Cross Surgery, Bury St Edmunds; immediate care doctor, LIVES and EMICS; co-vice chair, BASICS.

Address for correspondence

Edward Walter, Royal Surrey County Hospital, Egerton Road, Guildford, GU2 7XX, UK.

E-mail: ewalter@nhs.net

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INTRODUCTION

Exertional heat stroke (EHS) is a risk to athletes, the military, and others undergoing strenuous exertion, especially in temperate climates. It is defined as a core temperature of >40°C with neurological impairment. It is one of the three commonest causes of deaths in athletes, and, untreated, the mortality may be up to 80%. Even when treated, it is associated with significant short- and long-term morbidity. The number of cases of EHS appear to be on the rise; this may be due in part to increasing numbers of athletes participating in endurance events each year. Running USA estimates that 25 000 runners completed a marathon in the US during 1976; by 2016, this had grown to 507 600; similarly, the number of runners completing a half-marathon is estimated to have risen from 303 000 in 1990 to 1 900 000 in 2016.[1,2] However, the incidence may also be rising; the US military has reported an eight-fold increase in the rate of hospitalisation from EHS, from 1.8 to 14.5 per 100 000 soldiers, over a 20-year period.[3] There are also likely to be a number of runners who do not present to medical services, or in whom the signs are unrecognised.

A GP may have contact with athletes in one of three ways: a patient seeking advice before participation in a race; the GP providing medical cover on race day; or afterwards if a patient has suffered from EHS. This article aims to highlight current advice and research areas in the treatment of a patient.

ADVICE BEFORE A RACE

Most cases of EHS are sporadic, but a number of drugs and conditions are thought to increase the risk (see Boxes 1 and 2). However, some of these, for example, age and gender, are not modifiable, with athletes still choosing to compete despite the risks. The consultation should therefore focus on the athlete's awareness of the signs and symptoms, and the importance of when to seek help.

Competing in warmer or more humid conditions, associated with a higher wet-bulb globe temperature (WBGT) measurement, increases the risk. The WBGT incorporates a measurement of ambient temperature, humidity, wind speed, and solar radiation, and, as well as an indication of the risk of heat stress, is often used by organisers to limit or cancel endurance events if the risk is significant.

SIGNS AND SYMPTOMS OF ACUTE EHS

Hyperthermia with a core temperature >40°C, with neurocognitive dysfunction, is diagnostic — however, cutaneous vasoconstriction may mean that a peripheral temperature measurement is inaccurately low. A core temperature measurement (using a rectal thermometer) is required on any collapsed athlete.

In mild cases, patients may be agitated or confused; in severe cases, seizures and a reduced level of consciousness may be seen. Other conditions associated with endurance events, for example, exercise-associated collapse and hyponatraemia, may present similarly or coexist, and a high index of suspicion is required.

Patients tend to display a hyperdynamic circulation, and ECG changes (including

Box 1. Conditions that may increase the risk of heat stroke

- Conditions increasing heat production (for example, thyrotoxicosis)
- Current febrile illness
- Dehydration
- Increasing age
- Lack of physical fitness
- Lack of sleep or food
- Male sex
- Obesity
- Previous episode of heat stroke
- Protective clothing
- Skin diseases (for example, psoriasis)

Box 2. Drugs that may increase the risk of heat stroke

- Alcohol
- Amphetamines
- Anticholinergic and sympathomimetic agents
- Antihistamines
- Benzodiazepines
- Beta-blockers
- Calcium channel blockers
- Cocaine
- Diuretics
- Laxatives
- Neuroleptic medications
- Phenothiazines
- Thyroid agonists
- Tricyclic antidepressants

conduction defects, QT and ST changes, and T-wave abnormalities) and cardiac dysfunction are sometimes seen.

TREATMENT

Immediate cooling is the priority, along with maintaining a patent airway and adequate ventilation and circulation. Reducing the core temperature to below 38.9°C within 60 minutes is associated with an improved survival.[4]

Immersion in ice-cold water is probably the most efficient way of reducing body temperature,[5] although it is not always practical. Continual dousing with water combined with fanning the patient is an alternative method. There is a risk that patients become hypothermic during such aggressive cooling, and a core temperature of 38.6°C has been suggested as a limit to active cooling to avoid this.[6]

Patients should ideally be admitted to hospital for further assessment once cooling has occurred, for monitoring of multi-organ dysfunction. Heat illness is associated with renal failure in 13% of patients,[3] exacerbated by rhabdomyolysis and dehydration, and may require renal replacement therapy. Some sports physicians avoid non-steroidal anti-inflammatory agents because of the risks of renal injury, gastrointestinal permeability, and other deleterious effects. Hepatic failure has been reported, which may be severe enough to require acute liver transplantation. Disseminated intravascular coagulation (DIC) may also occur, and, after an episode of heat illness, there is a 40% increased risk of all-cause mortality even many years after the event,[7] although the mechanism for this is not clear.

Antipyretics, for example, paracetamol and aspirin, should not be used to reduce the hyperthermia because the mechanism is that of excessive heat generation rather than hypothalamic-induced heat retention. EHS is associated with malignant hyperthermia (MH); however, dantrolene, the definitive treatment for MH, is not advocated in EHS. Although much of the multi-organ dysfunction is likely to be due to thermal damage, it has been suggested that translocation of gastrointestinal compounds may generate sepsis or a pro-inflammatory state. Some animal trials have shown benefits from anti-inflammatory agents and antibiotics, but these are not yet advocated in humans.

ADVICE AFTER RECOVERY FROM ACUTE EHS

In patients seeking help after the acute episode, it is important to ensure that the organ dysfunction (for example, liver and renal injury, and coagulopathy) has resolved. Persistent organ dysfunction and cognitive abnormalities have been reported, and athletes should be aware that there is an increased risk of a further episode. The US National Athletic Trainers' Association reports that up to 20% of patients display a reduced heat tolerance after an episode of EHS, and that this intolerance may persist for up to 5 years.[8] Some authorities advise that EHS patients are referred and tested for MH.

The Faculty of Sports and Exercise Medicine advises that return to exercise should only occur when the athlete is asymptomatic and laboratory investigations have returned to normal,[9] and some authorities advocate no exercise for at least 1 week, regardless of other factors. After that, return to exercise should be gradual and paced, ideally under the guidance of a sports and exercise physician or athletic trainer. Some sports and exercise facilities offer heat tolerance testing, and it may be prudent to use this to gauge an individual patient's risk of recurrence, and to inform the rate of return to exercise.

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